

BERRY ELECTRONICS

**MODEL 314A
TRUNK TEST SET
OPERATING MANUAL**

MODEL 314A
TRUNK TEST SET

CONTENTS	PAGE
1. GENERAL	
A. Scope of Publication	1
B. Applications	1
C. Specifications	3
D. Unpacking and Inspection	3
2. DESCRIPTION	
A. General	6
B. Physical Description	8
C. Front Panel	8
3. OPERATION	
A. General	11
B. MF Signaling System	11
C. DTMF Signaling System	12
D. DP Signaling System	12
E. SF Signaling System	13
F. Verification Tests	13
G. Circuit Testing	13
H. Test Connections	14
I. Test Procedures	14
4. THEORY OF OPERATION	
A. General	20
B. Block Diagram	20
5. MAINTENANCE	
A. General	21
B. Service Information	21
C. Preventative Maintenance	21
FIGURES	
1. Model 314A Trunk Test Set	7
2. Model 314A Front Panel Callouts	9
3. Originating and Terminating Office E&M Jack Connections	15
4. Connections to Test 2-Wire Circuits ..	16
5. Connections to Test 4-Wire Circuits with E&M Supervision	17
6. Block diagram of the 314A Trunk Test Set	20
TABLES	
A. Terms, Abbreviations & Acronyms	2
B. Specifications	3
C. MF Signaling System	12
D. DTMF Signaling System	12

1. GENERAL

A. Scope of Publication

1.01 This publication describes the features, physical appearance, operation, and maintenance of the Model 314A Trunk Test Set. Application information and detailed testing procedures are also included. Brief descriptions of Multifrequency (MF), TOUCH-TONE* (DTMF), Dial Pulse (DP) and Single Frequency (SF) signaling systems are provided as an aid to understanding and using the Model 314A Trunk Test Set.

1.02 Whenever this publication is reissued, the reason for reissue will be listed in this paragraph.

1.03 Terms, abbreviations and acronyms used in this publication are listed in Table A.

B. Applications

1.04 The Model 314A Trunk Test Set is a portable Multifrequency (MF), TOUCH-TONE* (DTMF) and Dial Pulse (DP) sender combined with an autoranging digital levelmeter. The Model 314A Trunk Test Set may be used in all local and toll switching offices for testing trunks, trunk equipment, incoming registers and special service circuits. It may also be used at customer premise locations, e.g. PBX locations.

1.05 The Model 314A Trunk Test Set applications include:

- Circuit order testing of new trunks
- Routine maintenance testing of existing trunks
- Trouble testing of existing trunks
- Detection of defective trunk equipment, incoming registers and signaling equipment
- Transmission level measurements

1.06 The Model 314A Trunk Test Set features include:

- Sends Multifrequency (MF), TOUCH-TONE* (DTMF) and Dial Pulse (DP) address signaling
- Sends and displays LOOP, E&M and SF supervision (ON-HOOK/OFF-HOOK)
- High accuracy levelmeter

SECTION 100-314-A00

- Loop and Ground Start operation
- Stores and automatically sends two-stage pulsing for ANI, TSPS, and IDDD
- Provides all 16 TOUCH-TONE* (DTMF) codes for use with AUTOVON
- Provides all 15 Multifrequency (MF) codes including KP, ST, STP, ST2P and ST3P
- Portable-battery powered

TABLE A
TERMS, ABBREVIATIONS AND ACRONYMS

AIS	Automatic Intercept System
ANI	Automatic Number Identification
AUTOVON	Automatic Voice Operated Network
CAMA	Centralized Automatic Message Accounting
CCITT	Consultative Committee on International Telegraph and Telephone
CMOS	Complimentary Metallic Oxide Semiconductor
dBm	dB referenced to one milliwatt in 600 ohms. One milliwatt is zero dBm.
DDD	Direct Distance Dialing
DP	Dial Pulse
DTMF	Dual Tone Multifrequency (TOUCH-TONE*)
DVM	Digital Voltmeter (Levelmeter)
E&M	Signaling leads. E lead is receive and M is transmit
GS	Ground Start
Hz	Hertz
IDDD	International Direct Distance Dialing
KP	Key Pulse
LED	Light Emitting Diode
LOOP	Loop Signaling
MDF	Main Distributing Frame
MF	Multifrequency
OGT	Outgoing Trunk
PC	Printed Circuit
PPS	Pulses Per Second
RMS	Root Mean Square
SF	Single Frequency (2600 Hz)
ST	Start Pulse
STP	Start Pulse Used in TSPS and CCITT Signaling System No. 5
ST2P	Start Pulse Used in TSPS and CCITT Signaling System No. 5
ST3P	Start Pulse Used in TSPS and CCITT Signaling System No. 5
TLP	Transmission Level Point
TR	Tip and Ring (Transmit)
T1R1	Tip 1 Ring 1 (Receive)
TRS	Tip (T) Ring (R) Sleeve (S)
TN	Test Number
TSP	Traffic Service Position
TSPS	Traffic Service Position System
TT	TOUCH-TONE*
>	More Than
<	Less Than

*Registered Trademark of AT&T Co.

1.07 The Model 314A Trunk Test Set provides for monitoring of the supervision signaling (ON-HOOK/OFF-HOOK) for both the Originating (calling) and Terminating (Called) offices. In addition means are provided for audio monitoring and talking over the trunk being tested.

1.08 Typical telephone circuits which may be tested by the Model 314A Trunk Test Set are listed below by the type of signaling used:

- (a) Multifrequency (MF)
 - Intertoll Trunks
 - Interoffice Trunks
 - CAMA Trunks
 - TSP Trunks
 - TSPS Trunks
 - AIS Trunks
 - 911 Trunks
- (b) TOUCH-TONE* (DTMF)
 - Special Service Circuits
 - Control Circuits

- (c) Dial Pulse (DP)
 - Interoffice Trunks
 - Special Service Circuits

C. Specifications

1.09 Specifications of the Model 314A Trunk Test Set are shown in Table B.

D. Unpacking and Inspection

1.10 Before removing the Model 314A Trunk Test Set from its shipping container, carefully inspect the box for evidence of damage in transit. Upon opening the box, carefully unpack the unit from its protective packing material and inspect it for damage. Open the cover of the test set and check the operation of all switches and controls. If damage in transit is found, immediately notify the transportation common carrier. Save the shipping container and packing material in case a return is necessary.

TABLE B
SPECIFICATIONS

Pulsing Type of Pulsing MF Digits Generated DTMF Digits Generated DP Digits Generated	Multifrequency (MF), TOUCH-TONE* (DTMF) and Dial Pulse (DP) Digits 0 thru 9, KP, ST, STP, ST2P and ST3P Digits 0 thru 9, *, #, A, B, C and D Digits 0 thru 9
Timing MF Pulse Timing (AUTO or REPEAT SEND) TOUCH-TONE* Timing (AUTO or REPEAT SEND) Dial Pulse Timing Pause Timing	Tone On: 70 ms (100 ms for KP, 70 ms for ST) Tone Off: 70 ms Tone On: 50 ms Tone Off: 50 ms Speed: 10 PPS Percent Break: 61% Interdigital Time: 600 ms minimum 1 second for each PAUSE key actuation. An automatic 250 ms pause is inserted at the beginning of each AUTO or REPEAT SEND sequence to allow for Wink or Delay Dial start signals. Also a 250 ms pause is inserted between stages in two-stage outpulsing.
Frequencies Output Frequencies	Standard MF: 700, 900, 1100, 1300, 1500 and 1700 Hz Standard DTMF: 697, 770, 852, 941, 1209, 1336, 1477 and 1633 Hz Standard SF: 2600 Hz

*Registered Trademark of AT&T Co.

TABLE B (Continued)

SPECIFICATIONS

Frequencies (Continued) Frequency Accuracy Frequency Stability Output Waveform	Controlled by quartz crystal; Divide ratio accuracy typically within .2%; worst case divide ratio is within .5% Better than .01% MF or DTMF: Envelope formed by two sine waves. Each sine wave has <1% harmonic distortion. SF: 2600 Hz sine wave with <1% harmonic distortion.
Levels MF and DTMF Levels (Transmit) SF Levels (Transmit) Output Level Accuracy	2-Wire (0 db TLP): each tone is -6 dBm 4-Wire Originating (-16 dB TLP): each tone is -22 dBm 4-Wire Terminating (+7 dB TLP): each tone is +1 dBm Originating: T, R (-16 dB TLP): -36 dBm Terminating: T1, R1, (+7 dB TLP): -13dBm During Dial Pulse sending SF level increases 12 dB ± 1.0 dB ± 5 dB (MF, DTMF and SF)
Supervision Type of Supervision Supervision Sensors SF Receivers	LOOP, E&M or SF Loop: Voltage > 39V = ON-HOOK < 39V = OFF-HOOK < 3V = no indication E Lead: Voltage > 40V = ON-HOOK < 6V = OFF-HOOK 6V-40V = no indication M Lead: Voltage < 4.2V = ON-HOOK > 22V = OFF-HOOK 4.2V-22V = no indication T, R SF Receiver > -42 dBm 2600 Hz = Detect T1, R1 SF Receiver > -19 dBm 2600 Hz = Detect Bandwidth: ± 50 Hz Dynamic Range: 22 dB
Impedances Impedance (T, R) Impedance (T1, R1)	MONITOR: 500 K ohms SEND (2-Wire): 900 ohms $\pm 5\%$ SEND (4-Wire): 600 ohms $\pm 5\%$ MONITOR: 500 K ohms RECEIVE (4-Wire): 600 ohms $\pm 5\%$

TABLE B (Continued)
SPECIFICATIONS

Impedances (Continued) Impedance (E LEAD) Impedance (M LEAD)	MONITOR: 200 K ohms RECEIVE (ON-HOOK): open RECEIVE (OFF-HOOK): Ground MONITOR: 200 K ohms SEND (ON-HOOK): Ground SEND (OFF-HOOK): Battery (1 K ohm internal termination during send)
Digital Levelmeter DVM Level Range DVM Frequency Range DVM Resolution DVM Accuracy DVM Detector Type DVM Sample Rate	-54 dBm to +12 dBm 404 Hz to 2804 Hz (for specified accuracy) ±.1 dBm ±.1 dBm; ±1 Count (-30 dBm to +12 dBm) ±.3 dBm: ±1 Count (-54 dBm to -30 dBm) Average responding: calibrated in RMS 5 per second (10 per second during auto-ranging)
Miscellaneous Digit Storage	In AUTO or REPEAT SEND, sequences of up to 125 digits or pauses can be stored and outputted as desired.
Electrical Power Requirements Battery Life	10 "D" cell batteries or -42 to -56 VDC with a current drain of <100 mA as normally supplied by the central office battery. Central office battery is required if E&M supervision is sent. Approximately 200 hours
Environmental Temperature Range Relative Humidity	0 degrees to 50 degrees C (Operating or Storage) 0 to 90% No condensation
Mechanical Size (HxWxD) Weight Circuit Access	7.0 × 11.0 × 7.0 inches 17.8 × 27.9 × 17.8 centimeters 12 Lbs (5.5 Kgs) 310 type jacks; TR, T1R1, E&M, TELSET, -48, REMOTE

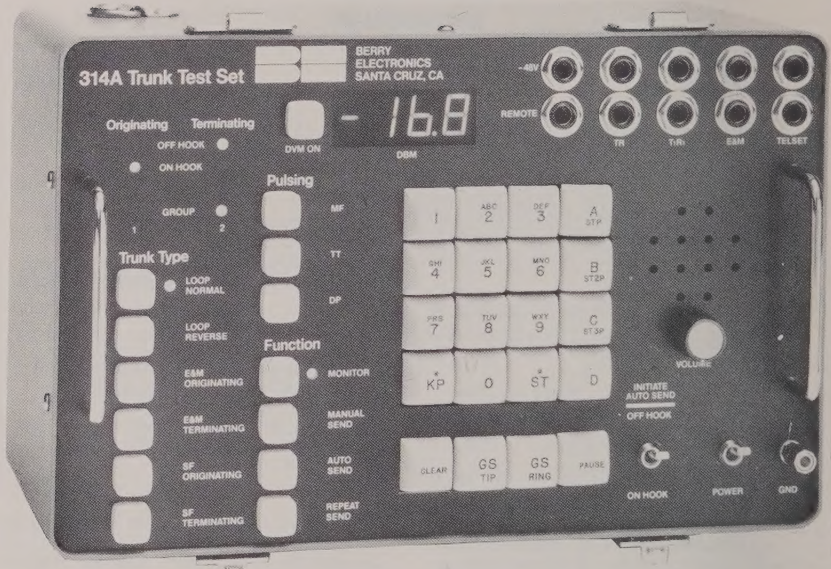


Figure 1. Model 314A Trunk Test Set

2.05 The four Function keys are used to select the operating mode of the 314A. In MONITOR operation, no pulsing or supervision is sent. The supervision LED display, digital levelmeter, and monitor speaker are connected to the trunk under test through a high impedance bridging input circuit to insure no circuit loading.

2.06 In MANUAL SEND operation, pulsing is sent as entered. For Multifrequency or TOUCH-TONE* pulsing, the appropriate tones are sent as long as a digit key is held down. For Dial Pulse sending, the 314A sends each Dial Pulse digit as the desired digit key is depressed. If a new digit is entered before the previous digit has been completely outpulsed, the 314A stores this digit and sends it after inserting the proper interdigital time period.

2.07 In AUTO SEND operation, the 314A automatically sends a previously entered (stored) digit sequence every time the ON-HOOK/OFF-HOOK switch is operated to the OFF-HOOK position. Digit sequences may be entered in any Function (MONITOR, MANUAL SEND, AUTO SEND or REPEAT SEND). Sequences may be up

to 126 digits in length. One or more one-second pauses may be entered anywhere in a digit sequence with the PAUSE key. This feature is useful in providing delays for a second dial tone at a PBX location, etc. Digit sequences may be divided into two groups for testing CAMA, TSPS and IDDD trunks (two-stage outpulsing). The GROUP 1 and 2 LED indicators located on the upper left side of the front panel indicate which group of digits is being sent. Different types of pulsing may be sent in each group. For example, the first group of digits could be Dial Pulse and the second group Multifrequency for testing CAMA or TSPS.

2.08 REPEAT SEND is similar in function to AUTO SEND except that after outpulsing of a sequence is complete, the 314A pauses for five seconds, momentarily goes ON-HOOK and then goes OFF-HOOK and sends the stored digit sequence again. This operation repeats until the ON-HOOK/OFF-HOOK switch is operated to the ON-HOOK position.

2.09 Send and receive levels for voice and signaling are automatically adjusted for two-wire,

*Registered Trademark of AT&T Co.

SECTION 100-314-A00

four-wire Originating and four-wire Terminating offices. Two-wire Originating operation selects 0 dBm TLP and 900 ohm impedance. Four-wire Originating operation selects 600 ohm impedance with a send level of -16 dBm TLP and a receive level of +7 dBm. Four-wire Terminating operation selects 600 ohm impedance with a send level of +7 dBm and a receive level of -16 dBm. This feature insures proper levels and impedance for the 314A in all local and toll offices.

2.10 The DIGITAL LEVELMETER in the 314A has a range of -54 dBm to +12 dBm with a resolution of .1 dBm. Autoranging is used to eliminate any manual switching. For signals above or below the operating range, the display flashes to indicate an over- or under-range condition. Automatic impedance switching is used to minimize operator errors. 900 ohms is used for two-wire trunks and 600 ohms for four-wire trunks. The levelmeter display is activated by depressing the DVM ON key. One operation of the key activates the display for five seconds; two operations for 30 seconds. This reduces current drain and extends battery life since the display is only used when needed for a level measurement.

2.11 Parallel-connected 310-type jacks (TR, T1R1, and E&M) provide for circuit access at six-wire jack locations. The parallel jacks permit the connection of other test sets to the trunk being tested. The TELSET jacks allow the user to communicate on the trunk being tested via a standard telephone headset (no gain is added). The REMOTE jack can be used to remotely operate the 314A ON-HOOK/OFF-HOOK switch by Tip-Sleeve and Ring-Sleeve contact closure.

2.12 The 314A is normally powered by internal batteries. A -48V input jack allows the user to power the 314A from the central office battery if desired. This jack is also used to provide the required central office battery when E&M supervision is selected.

B. Physical Description

2.13 The Model 314A Trunk Test Set is a portable test set equipped with a carrying handle attached to a nonremovable cover. The case is equipped with two D rings for attaching the leather ladder strap provided with the unit. When using the 314A on a ladder, the strap is used to secure the instrument to the ladder side rail. Test cords may be stored in the cover area but are not provided with the unit.

2.14 The Model 314A Trunk Test Set is 7 inches high, 11 inches wide and 7 inches deep (17.8 × 27.9 × 17.8 centimeters). It weighs 12 pounds (5.5 Kgs).

2.15 The case and cover are constructed of heavy gauge aluminum alloy. Both are finished with a medium blue flat textured paint. Four nonmarring rubber feet are provided on the bottom of the case. A removable battery access cover plate, secured by four screws, is attached to the bottom of the case.

C. Front Panel

2.16 The front panel layout, switches, jacks, controls and digital display readout are shown in Figure 2. The circled callout numbers in the figure correspond with the circled callout numbers in the following text:

- ① Originating OFF-HOOK/ON-HOOK LED's indicate the supervision status of the Originating office.
- ② GROUP 1/2 LED's indicate which number is being sent in two-stage pulsing.
- ③ Terminating OFF-HOOK/ON-HOOK LED's indicate the supervision status of the Terminating office.
- ④ Pulsing Key group:
 1. MF key selects Multifrequency pulsing
 2. TT key selects TOUCH-TONE* (DTMF) pulsing
 3. DP key selects Dial Pulsing
- ⑤ DVM ON key turns on the digital levelmeter DBM display for five seconds. Two operations of the key turns on the DISPLAY for 30 seconds.
- ⑥ Pulsing LED group:
 1. MF LED illuminated indicates Multifrequency pulsing was selected
 2. TT LED illuminated indicates TOUCH-TONE* (DTMF) pulsing was selected
 3. DP LED illuminated indicates Dial Pulsing pulsing was selected
- ⑦ DISPLAY indicates the power level in dBm of test tones in the 404 Hz to 2804 Hz frequency range. Test tones above +12.0 dBm will be indicated by a flashing 12.0 reading. Test tones below -54.0 dBm will be indicated by a flashing -54.0 reading.
- ⑧ KEYPAD is a 4×4 matrix of 16 keys used to enter and/or send address signaling digits and control code information. The three Pulsing keys (MF, TT and DP) control which of the KEYPAD keys are activated as follows:

*Registered Trademark of AT&T Co.

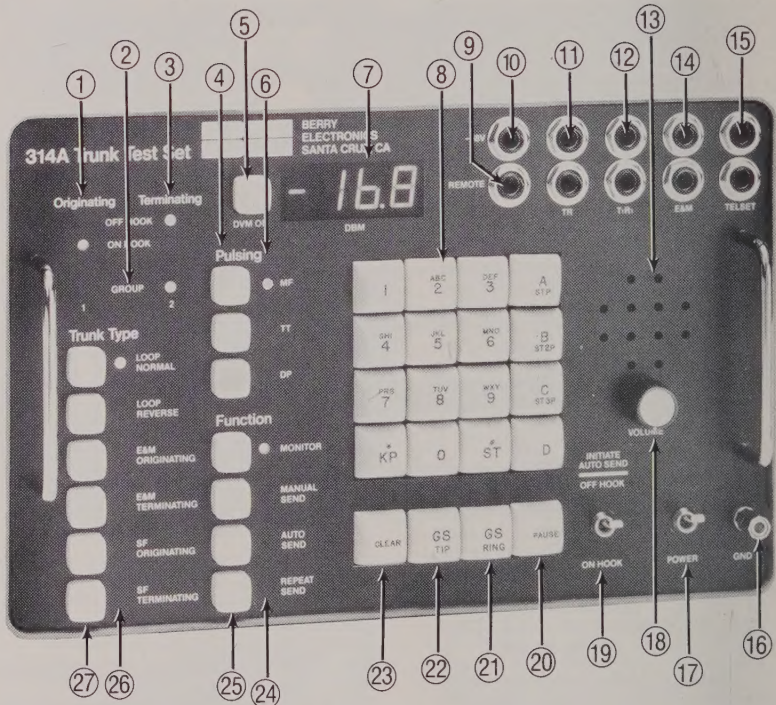


Figure 2. Model 314A Front Panel Callouts

When MF is selected, the keys will enter and/or send Multifrequency tones. Fifteen of the 16 keys are used for the digits 0 through 9, KP, ST, STP, ST2P and ST3P. The D key is not used in MF. For IDDD signaling (CCITT No. 5), KP2 is equivalent to ST2P.

When TT is selected, the keys will enter and/or send TOUCH-TONE* (DTMF) tones. All 16 of the keys are used; digits 0 through 9, *, #, A, B, C, D.

When DP is selected, the keys will enter and/or send Dial Pulse digits. Only 10 of the 16 keys are used; digits 0 through 9. Dial Pulsing is at 10 PPS and 61% break.

9 REMOTE jack allows a cord to be used to start and stop send sequences of the 314A. Sending is started by momentarily connecting Tip to Sleeve (OFF-HOOK). Sending is stopped by momentarily connecting Ring to Sleeve (ON-HOOK). Some offices are equipped with a Harness and Push button that are compatible with the above function.

10 -48V jack provides an input for -48 VDC central office battery. -48 is connected to Tip. Ground is connected to Sleeve. When making this connection, it is advisable to connect the cord to the 314A first. Plugging in to this jack disconnects the internal batteries. NOTE: -48V MUST BE SUPPLIED WHEN SENDING ON E&M TRUNKS.

*Registered Trademark of AT&T Co.

SECTION 100-314-A00

- ⑪ TR jacks connect TR of the trunk to the 314A. These jacks are normalled through so a single or double cord may be used.
- ⑫ T1R1 jacks connect T1R1 of the trunk to the 314A. Plugging in these jacks "tells" the 314A that a four-wire test is intended. These jacks are normalled through so a single or double cord may be used.
- ⑬ LOUDSPEAKER for monitoring circuit activity
- ⑭ E&M jacks connect the signalling leads to the 314A. E lead connects to Tip and M lead connects to Ring. These jacks are also normalled through so single or double cords may be used.
- ⑮ TELSET jacks allow the use of an operators headset to communicate on the trunk under test (Receiver connects to Sleeves and transmitter connects to Tips). Sound can adversely affect the tests (through the transmitter) so use the headset only when necessary.
- ⑯ GND connection allows for connecting central office ground to the test set when it is powered by internal batteries. If central office battery is supplied via the —48V jack, central office ground is supplied with the same cord.
- ⑰ POWER switch applies power to the test set and initiates the microprocessor self test. Following the self test, the 314A will set itself up in the most commonly used mode of operation.
- ⑱ VOLUME control allows the operator to adjust the loudness level of the monitor SPEAKER. T,R is monitored for two-wire trunks, T,R and T1,R1 are monitored for four-wire trunks. Different gains are used for T,R and T1,R1 when monitoring four-wire trunks to compensate for the differences in signal level. Even if the VOLUME control is turned all the way down, the beep sound, indicating the acceptance of a digit key or operation of the CLEAR or PAUSE key, will come through the speaker at a normal level.
- ⑲ ON-HOOK/OFF-HOOK (INITIATE AUTO SEND) switch performs two functions. It seizes the trunk to which the 314A is connected, when switched to the OFF-HOOK position (if not in MONITOR function), and it enables outpulsing in the MANUAL SEND, AUTO SEND and REPEAT SEND function. Its position will indicate the correct activity of the switch except when the REMOTE jack is used (see item 9).
- ⑳ PAUSE key enters a one-second pause into the dialing sequence each time it is operated. It is useful in providing delays in the "wait for second dial tone" needed in the typical PBX. It also may be used to add extra time between calls, for disconnect, in the REPEAT SEND mode.
- ㉑ GS RING key is used to test on "Ground Start" trunks. It applies ground on the Ring lead as long as the key is depressed and is used for LOOP NORMAL trunks.
- ㉒ GS TIP key is used to test on "Ground Start" trunks. It applies ground on the Tip lead as long as the key is depressed and is used for LOOP REVERSE trunks.
- ㉓ CLEAR key clears all digits and codes from the Send-Memory.
- ㉔ Function LED group:
 1. MONITOR LED illuminated indicates MONITOR function was selected.
 2. MANUAL SEND LED illuminated indicates MANUAL SEND function was selected.
 3. AUTO SEND LED illuminated indicates AUTO SEND function was selected.
 4. REPEAT SEND LED illuminated indicates REPEAT SEND function was selected.
- ㉕ Function Key group:
 1. MONITOR key selects the MONITOR function. High impedance bridging is used to ensure no interference with normal trunk operation. Trunk supervision is displayed on the Originating and Terminating ON-HOOK/OFF-HOOK LEDs. Circuit activity may be monitored via the LOUDSPEAKER and/or headset receiver and test tone levels may be measured by depressing the DVM ON key.
 2. MANUAL SEND key selects the MANUAL SEND function. For MF and TT signaling the signaling tones are sent out for as long as a KEYPAD key is depressed. This allows the operator to send short or long tone pulsing as desired. Dial Pulsing (DP) is sent at 10 PPS and 61% break. If Dial Pulse digits are entered faster than they can be sent, the 314A goes into a storage mode and sends digits with a 600 millisecond interdigital interval until the sending catches up with the entering. Whether MF, TT or DP sig-

naling is selected, all digits and/or codes sent are also entered and stored in the Send-Memory.

3. AUTO SEND key selects the AUTO SEND function. Operation of the ON-HOOK/OFF-HOOK switch to the OFF-HOOK (INITIATE AUTO SEND) position will cause the pulsing sequence, previously stored in the Send-Memory, to be sent. All outpulsing is initiated following the 250 millisecond delay period from seizure (OFF-HOOK). MF pulsing is 100 ms on for KP, 70 ms on for all other digits and codes, and 70 ms interdigital intervals. TT pulsing is 50 ms on and 50 ms off. DP pulsing is at a 10 PPS rate, 61 ms break, 39 ms make and 600 ms interdigital intervals. The stored pulsing sequence is sent only once and the trunk remains seized until the ON-HOOK/OFF-HOOK switch is operated to the ON-HOOK position.
4. REPEAT SEND key selects the REPEAT SEND function. Operation is identical to the AUTO SEND function except that the outpulsing sequence is repeated continuously. Following each outpulsing sequence the 314A allows five seconds for call completion and then automatically goes ON-HOOK for one second before initiating a new trunk seizure. The REPEAT SEND function is terminated by operating the ON-HOOK/OFF-HOOK switch to the ON-HOOK position.

26

Trunk Type LED group:

1. LOOP NORMAL LED illuminated indicates LOOP NORMAL trunk supervision was selected.
2. LOOP REVERSE LED illuminated indicates LOOP REVERSE trunk supervision was selected.
3. E&M ORIGINATING LED illuminated indicates E&M Originating trunk supervision was selected.
4. E&M TERMINATING LED illuminated indicates E&M Terminating supervision was selected.
5. SF ORIGINATING LED illuminated indicates SF Originating trunk supervision was selected.
6. SF TERMINATING LED illuminated indicates SF Terminating trunk supervision was selected.

27

Trunk Type Key group:

1. LOOP NORMAL is selected for trunks with Loop Normal supervision. Loop Normal trunks have Battery on Ring for Terminating office ON-HOOK and Battery on Tip for Terminating office OFF-HOOK.
2. LOOP REVERSE is selected for trunks with Loop Reverse supervision. Loop Reverse trunks have Battery on Tip for Terminating office ON-HOOK and Battery on Ring for Terminating office OFF-HOOK.
3. E&M ORIGINATING is selected for trunks with E&M supervision when the test set is in the Originating office. In the Originating office the M lead is used for Originating office supervision and the E lead is used for Terminating office supervision. (NOTE: -48V CONNECTION REQUIRED FOR E&M SEND FUNCTIONS).
4. E&M TERMINATING is selected for trunks with E&M supervision when the test set is in the Terminating office. In the Terminating office the M lead is used for Terminating office supervision and the E lead is used for Originating office supervision. (NOTE: -48V CONNECTION REQUIRED FOR E&M SEND FUNCTIONS).
5. SF ORIGINATING is selected for trunks with Single Frequency (SF) supervision when the Test Set is in the Originating office.
6. SF TERMINATING is selected for trunks with Single Frequency (SF) supervision when the Test Set is in the Terminating office.

3. OPERATION

A. General

3.01 This section provides instructions for using and operating the Model 314A Trunk Test Set. The operating procedures include a brief description of the procedure and its purpose. Basic information on MF, TT, DP, and SF signaling systems is also presented.

B. MF Signaling System

3.02 The MF signaling method uses six frequencies in the voice frequency band. A combination of two of the six frequencies represents a digit or control code. Ten tone combinations are

SECTION 100-314-A00

used for the 10 numeric digits (0-9), one combination for the (ST) signal and another for the (KP) signal. The three remaining tone combinations are used to provide other special signals (control codes).

3.03 On intertoll circuits, MF signaling is used to transmit the address information and SF signaling provides the circuit supervision signals. For most MF systems, the outpulsing rate is between 58 and 75 milliseconds for the pulse and interdigital intervals, or about 7 to 10 digits per second. MF signals are usually transmitted at a -6 or -7 dBm level below the circuit voice level. Table C shows the digits and frequencies along with the control function performed by the special codes.

TABLE C
MF SIGNALING SYSTEM

DIGIT OR CODE	MF FREQ IN Hz	CCITT SYS NO. 5
1	700 + 900	KP1
2	700 + 1100	
3	900 + 1100	
4	700 + 1300	
5	900 + 1300	
6	1100 + 1300	
7	700 + 1500	
8	900 + 1500	
9	1100 + 1500	
0	1300 + 1500	
KP	1100 + 1700	Code 12
ST	1500 + 1700	
STP	900 + 1700	
ST2P	1300 + 1700	
ST3P	700 + 1700	Code 11
KP = Preparatory for digits ST = End of pulsing STP, ST2P, ST3P = Control codes		

C. DTMF Signaling System

3.04 The DTMF signaling system was developed to provide a means for push-button signaling from subscriber telephones using the voice transmission path. Two groups of voice frequency tones are used to provide 16 different signals. The signal frequencies are geometrically spaced and no two frequencies of any signal combination are harmonically related.

3.05 Each of the 16 signals available consist of one tone from a HIGH group and one tone from a LOW group. Each group is made up of four tones. The normal phone is only capable of producing 12 of these signals. They are the digits 0 through 9 along with the # and *. The signals A, B, C and D are used for special services provided

to the U. S. Government. Table D shows the digits and tone frequencies used for DTMF signaling.

TABLE D
DTMF SIGNALING SYSTEM

DIGIT OR CODE	DTMF FREQ IN Hz
1	697 + 1209
2	697 + 1336
3	697 + 1477
4	770 + 1209
5	770 + 1336
6	770 + 1477
7	852 + 1209
8	852 + 1336
9	852 + 1477
0	941 + 1336
*	941 + 1209
#	941 + 1477
A	697 + 1633
B	770 + 1633
C	852 + 1633
D	941 + 1633
* # A B C D are special purpose codes	

D. DP Signaling System

3.06 A rotary dial transmits digital information by opening and closing the circuit, which is really a sequence of ON-HOOK/OFF-HOOK signals. The numerical digit dialed is determined by the number of ON-HOOK intervals in the train of pulses. Pulses are usually generated at a rate of 10 per second with a 58 to 64 percent break ratio.

3.07 Dial Pulse (DP) signaling is used to transmit address digits (called number) from a customer's dial to the serving central office. It is also used to transmit address digits from one central office to another over telephone trunks.

3.08 Dial Pulse signaling is accomplished by making and breaking a DC series "loop" circuit. The cam-operated contacts of a rotary dial perform this function for subscriber-loop signaling. Relay contacts in the outgoing trunk circuit perform the same function for interoffice trunk signaling.

3.09 For Dial Pulse signaling, the make interval is the OFF-HOOK period and the break interval is the ON-HOOK period. The break or ON-HOOK intervals are the dial pulses. A train of pulses with four ON-HOOK intervals represents the digit 4, as an example. Dial Pulse signaling is ordinarily thought of as -48V battery and ground signaling.

E. SF Signaling Systems

3.10 SF signaling is an "In-Band" signaling system which uses voice band frequencies of 2400/2600 Hz. SF signaling is primarily used to provide supervision (ON-HOOK/OFF-HOOK) for circuits using MF pulsing. The SF unit sends and receives central office DC signals on the E and M leads respectively and sends and receives voice frequency SF tones on the trunk. On 4-wire circuits the SF unit uses 2600 Hz in both directions of transmission.

3.11 SF units have a pulsing speed of 7.5 to 12.5 pulses per second when used to transmit Dial Pulse signaling. SF tone levels are usually 20 dB below voice level in the ON-HOOK condition and 8 dB below voice level during the OFF-HOOK condition.

F. Verification Tests

3.12 The purpose of the verification test procedure is to verify that the Model 314A Trunk Test Set is in good working condition prior to any circuit testing.

3.13 The 314A may be powered by -48VDC central office battery or by internal batteries. -48 VDC central office battery must be used for E&M type trunks.

3.14 **WARNING:** Always connect the patch cord to the -48V jack of the 314A first. Then connect the other end to the central office battery. This procedure avoids accidentally shorting the -48VDC to ground by inadvertently grounding the tip of the cord.

3.15 Perform the following verification test procedure steps in the order given:

1. Connect the GND binding post of the 314A to central office ground if using internal battery power (Ground is supplied via the patch cord if using -48VDC power).
2. Operate the POWER switch to the ON position. This will cause the 314A to go through a self-test of the microprocessor system. Two things should occur:
 - a) The DISPLAY will show four 8's for about 5 seconds and then extinguish.
 - b) The 314A will set itself up in the most commonly used mode of operation. An LED indicator should be illuminated to indicate the following selections:

Trunk Type — LOOP NORMAL
Pulsing — MF
Function — MONITOR

3. Failure of the self-test routine will cause one of the GROUP LED indicators to illuminate and the test set will go into an unresponsive wait mode. In this case the test set should be returned to BERRY ELECTRONICS for repair in accordance with the instructions given in Section 5, MAINTENANCE.

G. Circuit Testing

3.16 Testing with the 314A falls into two categories. These are SENDING and MONITORING. When used in the SENDING mode, the 314A acts as the Originating office, seizing the trunk and sending the outpulsing sequence just as the real Originating office would. These types of Originating office supervision may be simulated including LOOP, E&M, and SF.

3.17 Sending of pulsing sequences can be done manually, or from the 314A memory as a formatted pulsing sequence. Outpulsing sequences can be single stage or multistage, and be of same or mixed types of pulsing. The memory for storing of outpulsing sequences is very large (126 cells) so that there is no limitation on the length of the composite sequence.

3.18 In the MONITOR mode high impedance bridging is used to insure no interference to the trunk being monitored. In addition, a built-in speaker and headset jack allows an audible indication of the progress of outpulsing and signals returned from the called office as well as communication over the trunk.

3.19 The easiest method of gaining access to the circuit to be tested is at a jack location. Circuit jacks are usually provided at:

- Testboards
- Switchboards
- Test Positions
- Carrier System Patch Bays
- Central Office Equipment Bays
- Outgoing Trunk Test Frame (OGT)

Most jacks, such as LINE and DROP jacks, are of the normalised through type. Plugging into the LINE or DROP jack will "bust" the circuit. **CAUTION:** Because of this extreme care should be taken to avoid interrupting, working, in service circuits. Always obtain a release of in service circuits before proceeding with any testing.

3.20 The 314A automatically sets itself for the correct impedance and transmission level for the type of circuit to be tested. This is accomplished when the appropriate Trunk Type key is selected. The digital levelmeter reading is also automatically corrected for the impedance of the circuit under test, ie: 600 or 900 ohms as required.

SECTION 100-314-A00

H. Test Connections

3.21 Various terms are in common usage in the telephone plant to describe the direction that signals flow and to identify the points of trunk equipment access for testing. Typical of these are:

CALLING	—	CALLED
SENDING	—	RECEIVING
LINE	—	DROP
ORIGINATING	—	TERMINATING
T,R	—	T1,R1

3.22 There are subtle differences in the above terms that can lead to uncertainty in the connecting of test sets to trunk facilities. To eliminate problems in this area, we have used the terms ORIGINATING and TERMINATING in labelling the Trunk Type keys of the 314A, and the designations T,R, and T1,R1 for labelling of the voice-frequency jacks.

3.23 A convenient memory aid is to add the word "OFFICE" to the terms ORIGINATING and TERMINATING in thinking about the function that the Test Set is to perform. If the Test Set is to assist an Originating office to test a trunk toward a far-end Terminating office, then an ORIGINATING Trunk Type key would be selected on the 314A. If the Test Set is to help check out a Terminating office, then a TERMINATING Trunk Type key would be selected.

3.24 For example, assume that the 314A is in an Originating office and is to send an outpulsing sequence to test a trunk equipped with E&M supervision. The voice-frequency jack T,R would be connected to the carrier MOD-IN jack to send the MF outpulsing to the far-end Terminating office. The T1,R1 jack is connected to the carrier DEMOD-OUT jack. The E&M jack of the 314A would be connected to the LINE side of the trunk signaling jacks.

3.25 If the testing location is a Terminating office, then the E&M TERMINATING Trunk Type key would be selected on the 314A, and the E&M jack would be connected to the DROP side of the trunk signaling jacks. The T,R, and T1,R1 jacks are connected to the carrier EQPT-OUT and EQUIP-IN jacks with circuitry in the 314A changing the jack's function and levels as required for a Terminating office.

3.26 LOOP type circuits are an exception to the "ORIGINATING/TERMINATING" rule and are thus simply referred to as LOOP NORMAL and LOOP REVERSE on the 314A Trunk Type keys.

3.27 Figure 3 shows the 314A E&M jack connections for Originating and Terminating type offices. The 314A T,R and T1,R1 voice frequen-

cy jack connections are made as previously described.

3.28 Figure 4 shows the connections required for testing 2-wire circuits. As shown, use of only a single cord will "bust" the circuit. When using a double cord with double plugs, always plug into the 314A jacks first and the circuit access jacks last. When disconnecting, unplug from the circuit access jacks first and the 314A jacks last. This procedure avoids circuit interruptions.

3.29 Figure 5 shows the connections required for testing carrier derived 4-wire circuits, with E&M supervision, at the 6-wire patch bay location.

I. Test Procedures

General

3.30 The power requirements for the 314A vary according to the application of the test set. To operate in the MONITOR mode, only a GROUND connection is required, with the 314A operating on self-contained batteries. To send on E&M trunks requires the addition of -48V. If -48V is required, a standard 310 cord is used to connect central office -48V battery to the 314A. Ground is supplied via the patch cord.

3.31 After the appropriate power and ground have been connected to the 314A, perform the verification test procedure prior to any circuit testing. See part F. Verification Tests.

3.32 To talk on the trunk under test, an operator type headset must be connected to the TELSET jacks of the 314A. Condition the 314A for the Trunk Type, Pulsing, and Function required, keypulse the number of the location desired and operate the "HOOK" switch to the OFF-HOOK position.

3.33 Transmission measurements of received tone level may be made by operating the DVM ON key. One operation of the key is good for a five-second reading and a second operation of the key extends the reading an additional 30 seconds. Readings will appear on DBM Digital Levelmeter.

3.34 Circuit information may be obtained from the Circuit Layout Record (CLR) or equivalent document. The following information must be determined from the Circuit Layout Record, or other sources, prior to circuit testing:

- Type of supervision used: LOOP NORMAL, LOOP REVERSED, E&M or SF
- ORIGINATING or TERMINATING office
- Type of pulsing used: MF, TT or DP
- Location of circuit access jacks
- 2-wire or 4-wire circuit

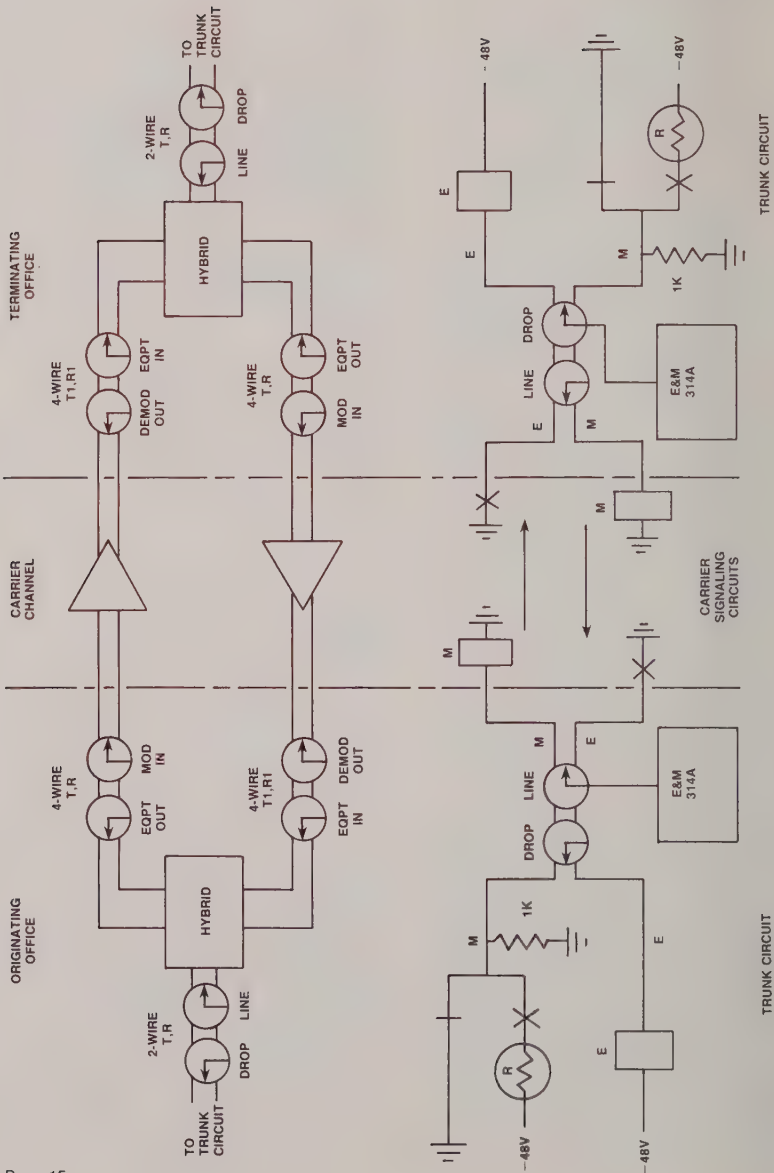


Figure 3. Originating and Terminating Office E&M Jack Connections

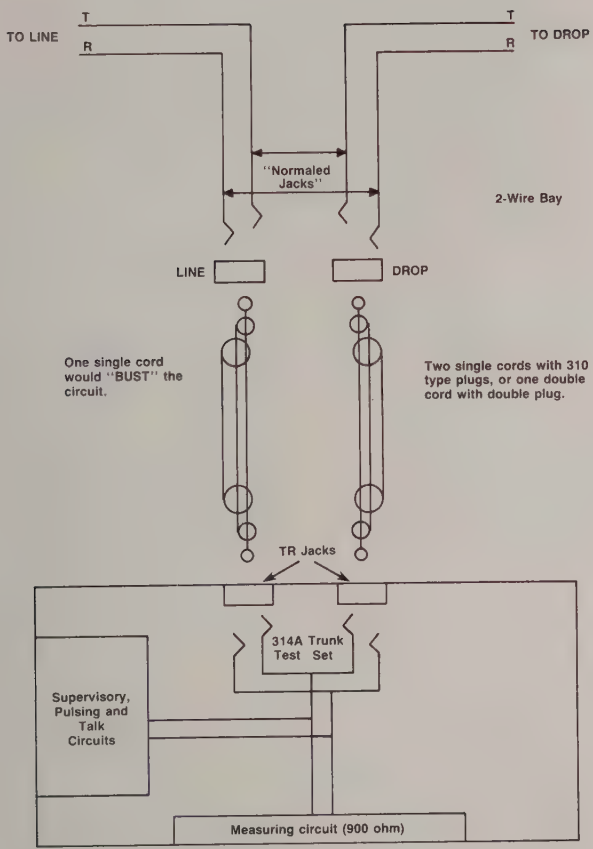


Figure 4. Connections to Test 2-Wire Circuits

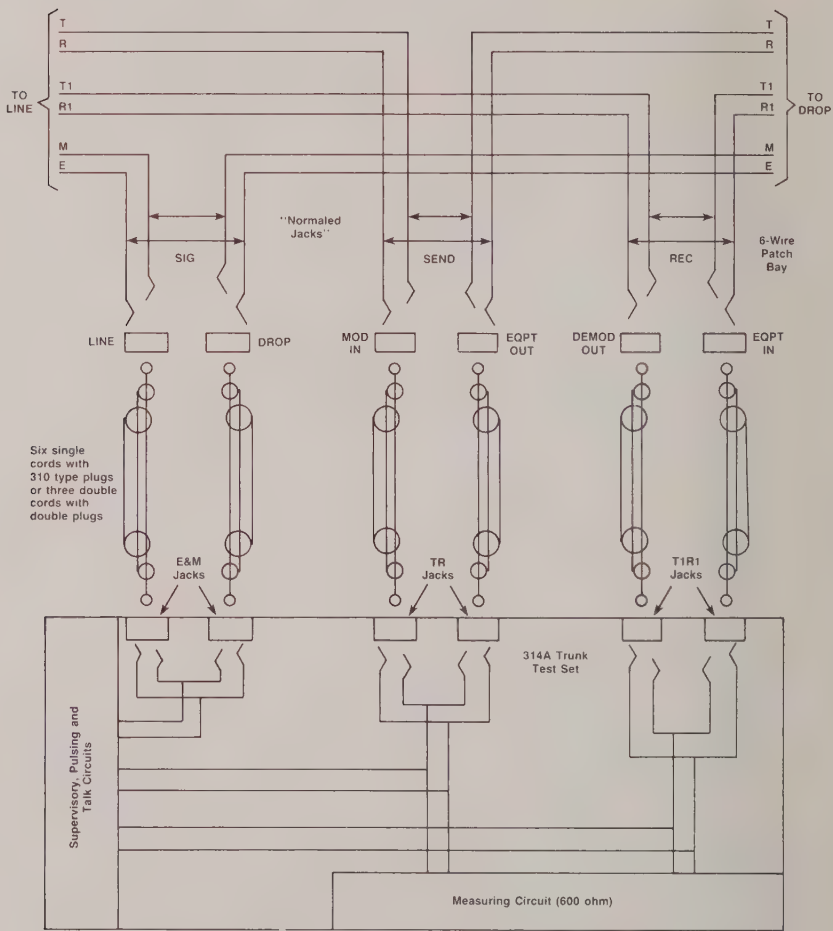


Figure 5. Connections to Test 4-Wire Circuits with E&M Supervision

SECTION 100-314-A00

The type of test to be made, MONITOR, MANUAL SEND, AUTO SEND or REPEAT SEND should also be determined.

Initial Conditions

3.35 Observe the control keys that were automatically selected on powerup. Determine if these are the appropriate selections needed for testing. If the correct selections have not been made, select the correct control keys from the following three groups of controls:

- Trunk Type
- Pulsing
- Function

3.36 When the MANUAL SEND key is selected, the type of signaling outpulsed is determined by which Pulsing key was chosen ie: MF, TT or DP.

3.37 When AUTO SEND or REPEAT SEND is selected, the type of signaling outpulsed is determined by the type previously entered into the Send-Memory. The Pulsing key selection indicated does not determine the type of signaling outpulsed in this case.

3.38 The ON-HOOK/OFF-HOOK switch not only controls the seizing of the trunk or loop but also initiates the outpulsing for the AUTO SEND or REPEAT SEND functions. In order to outpulse in the MANUAL SEND function, the ON-HOOK/OFF-HOOK switch must be in the OFF-

HOOK position. In the MONITOR function, operating the switch does nothing thus insuring that the connecting trunk or loop is not accidentally distrubed. If the ON-HOOK/OFF-HOOK switch is set to the OFF-HOOK position in the MONITOR function and then subsequently a SEND function is selected, the switch may have to be operated to the ON-HOOK position and then to the OFF-HOOK position to initiate the outpulsing.

3.39 Refer also to the discussion under REMOTE jack for remotely controlling the ON-HOOK/OFF-HOOK switch. See Paragraph 2.16, item 9.

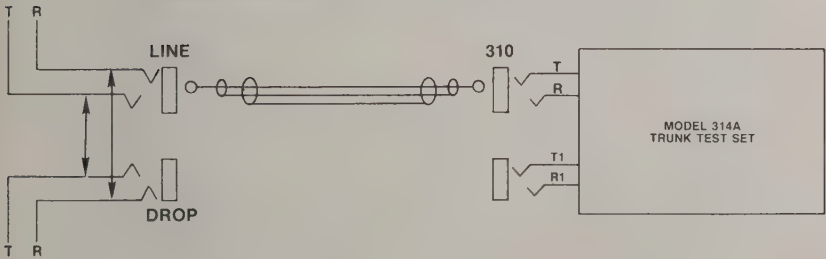
3.40 When the GS TIP or GS RING key is depressed, the Tip or Ring, respectively, of the trunk is grounded until the key is released.

Testing

3.41 The test procedures which follow are representative examples only. They are not intended to be all inclusive but rather to show, in a general fashion how testing is accomplished with the 314A. The testing procedures are:

- (a) TEST PROCEDURE NO. 1: SINGLE STAGE OUTPULSING-DIAL PULSE ON LOCAL LOOP
- (b) TEST PROCEDURE NO. 2: SINGLE STAGE OUTPULSING-MF DDD CALL
- (c) TEST PROCEDURE NO. 3: TWO STAGE OUTPULSING-DIAL PULSE FOLLOWED BY MULTIFREQUENCY

TEST PROCEDURE NO. 1
SINGLE STAGE OUTPULSING — DIAL PULSE ON LOCAL LOOP



STEP	PROCEDURE
1	If the test set has been in use, clear the send memory by momentarily depressing the CLEAR key. A beep signifies that the CLEAR command was accepted. Select Dial Pulse signaling by operating the DP key. The LED adjacent to the DP key will light.
2	The MANUAL SEND function is suggested to demonstrate this type of sending. Select the MANUAL SEND function by depressing the MANUAL SEND key. The LED adjacent to the key will light.
3	Select the LOOP NORMAL Trunk Type by depressing the LOOP NORMAL key.
4	Verify the "HOOK" switch is in the ON-HOOK position.
5	Connect the Local Loop to the T,R, jack on the 314A. Verify the GND binding post is connected to central office ground (or that -48V CO battery supply is being used).
6	Go OFF-HOOK with the "HOOK" switch. Verify dial-tone is received from the CO. To allow time for the first dial-tone (upon resending of the sequence stored in the process of sending), push the PAUSE key once for each second of wait desired, for 3 seconds of wait time, push the PAUSE key 3 times.
7	Key-pulse the test number for the outpulsing sequence desired. A suggestion is to dial-up the 1004 Hz local test tone (milliwatt number).
8	If the 1004 Hz tone was called up in the dialing sequence, to demonstrate the operation of the DBM meter operate the DVM-ON key when the 1004 Hz tone is heard.
9	To demonstrate that the sequence was loaded into the send memory, go ON-HOOK with the "HOOK" switch, and select the REPEAT SEND function. The LED adjacent to the key will light.
10	Go OFF-HOOK with the "HOOK" switch to initiate sending. In the REPEAT SEND function, the sending sequence will repeat continuously with a 5 second hold after the sequence has outpulsed, and then a 3.3 second ON-HOOK period to wait for circuit disconnect before again repeating the sequence.
11	To release the trunk, go ON-HOOK with the "HOOK" switch (or depress the "Stop" button on the harness plugged into the REMOTE jack on the front panel).
NOTE: 1. TOUCH-TONE* (DTMF) can be demonstrated in an office equipped with DTMF registers by simply substituting TT signaling for DP and repeating the procedure.	

TEST PROCEDURE NO. 2

SINGLE STAGE OUTPULSING — MF DDD CALL

STEP	PROCEDURE
1	If the test set has been in use, clear the send memory by momentarily depressing the CLEAR key. A beep signifies that the CLEAR command was accepted.
2	Select the MONITOR function by momentarily depressing the MONITOR key. Verify the LED adjacent to the key lights.
3	Select MF signaling by depressing the MF key. The LED adjacent to the key will light.
4	Select the Trunk Type desired by depressing the key for that trunk type. For example, select the E&M ORIGINATE key. The LED adjacent to the key will light. This sets up the E&M sending for an Originating office.
5	Connect the 314A to the E&M Originating trunk. Verify that -48V is connected to the -48V jack. The TR and E&M jacks should be connected to the trunk with 310 cords for 2-wire circuits. If the trunk is a 4-wire circuit, connect T1,R1 also (See Figures 3, 4 and 5)
6	Depress the digit keys, in order, for the number to be outpulsed.
7	Select the AUTO SEND function by depressing the AUTO SEND key. Verify the LED adjacent to the key lights.
8	Go OFF-HOOK with the "HOOK" switch (or momentarily depress the "Start" push-button on the harness plugged into the REMOTE jack on the front panel). This initiates trunk seizure and outpulsing of the stored sequence.
9	The AUTO SEND function automatically enters a 250 millisecond delay following the seizure of the trunk. Following the outpulsing, the trunk will remain seized until release by operating the "HOOK" switch to ON-HOOK (or by momentarily depressing the "Stop" button of the harness plugged into the REMOTE jack on the front panel).

*Registered Trademark of AT&T Co.

TEST PROCEDURE NO. 3

TWO STAGE OUTPUTSING — DIAL PULSE FOLLOWED BY MULTIFREQUENCY

STEP	PROCEDURE
1	A two stage outputsing sequence over a trunk involves nothing more than loading the two sequences, having previously selected the proper signaling type. In this case the two sequences are DP followed by MF. The delays required by the trunk supervision are automatically entered by the 314A.
Notes: 1. For PBX trunks where an access number is dialed, add enough PAUSES, at one second per key operation, to allow for the wait for dial-tone. Three seconds is usually adequate. 2. To add additional OFF-HOOK hold time to a sequence that is to be sent via the REPEAT SEND function, it is only necessary to add as many pauses as are required after the last digit of the sequence. Each operation of the PAUSE key enters a one second delay.	

4. THEORY OF OPERATION

A. General

4.01 A detailed discussion of the theory of operation is outside the scope of this publication. However, a block diagram and a brief description of operation is included.

B. Block Diagram

4.02 The block diagram is laid out in three levels, each level corresponding to a P-C board of the 314A. Figure 6 shows the block diagram of the 314A.

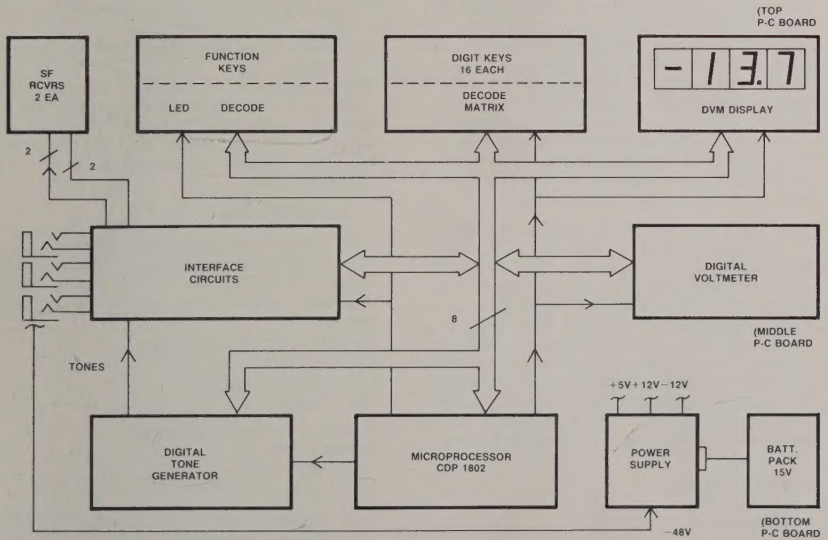


Figure 6. Block Diagram of the 314A Trunk Test Set

4.03 The top P-C board contains two SF Receivers for detecting the 2600 Hz SF signals. The detected information is routed to the interface section of the middle P-C board for entry to the micro-processor. The top P-C board also contains the Function keys and Function LEDs. The circuitry driving the LEDs is unique in that a current source is steered through the ON LEDs thus conserving battery power over that of conventional LED drivers. Also on the top P-C board are the Digit keys for entry of the send sequence, and matrix-decoding of the keys for entry to the processor. The key decoding algorithm will select the first key down and will debounce it ignoring any additional keys until the first key is released. The LED display for the DVM is also located on the top P-C board. By the use of the DVM-ON key in which the display is on only when used, a bright LED type display easily read in all light conditions could thus be used without compromising battery operation.

4.04 The middle P-C board contains the circuitry to interface the telephone trunks to the 314A. Electronic switching is used instead of relays to conserve battery power and improve reliability. The middle P-C board also contains the digital voltmeter circuitry. This circuitry is novel in that the ladder attenuator uses stable metal-film resistors arranged such that the temperature coefficients cancel and the resistance of the electronic switches has negligible effect on the performance of the attenuator. Digital information is passed to and from the digital voltmeter circuitry and the interface circuitry to the micro-processor.

4.05 The lower P-C board contains the micro-processor which is the heart of the Test Set, the Digital Tone Generator, the D-C to D-C converter Power Supply, and the connection to the Battery Pack. The Digital Tone Generator is a novel combination of counters and digital-to-analog converters which combine the desirable features of digital precision with a type of micro-processor control that does not require a super-high speed processor instruction rate. This allows a battery-saving CMOS micro-processor to be used, further enhancing the portability feature.

5. MAINTENANCE

A. General

5.01 The Model 314A Trunk Test Set uses a CDP 1802 microprocessor for all its functions. All signaling timing intervals, and display decoding are precisely controlled by a common time base. No field calibration is required.

5.02 Field repairs of the 314A are not recommended. For technical assistance, contact the Repair Department at BERRY ELECTRONICS, Inc. (408) 429-1857.

B. Service Information

5.03 Complete warranty information is contained in the purchase order agreement under terms and conditions of sale. Summarized briefly, all BERRY ELECTRONICS, Inc. products are warranted against defects in materials and workmanship for one year from the date of shipment.

C. Repairs

5.04 Any Berry Electronics, Inc. product found to be defective must follow this procedure:

- A) Call and request a Material Return Authorization Number (MRA) from Customer Service in Santa Cruz, Calif., 408-429-1857.
- B) Select either our Midwest Repair facility (New London, Minn.) or the Santa Cruz facility.
- C) Provide a P.O. number.
- D) Display the MRA number on the outside of the shipping carton, and all accompanying paper work.
- E) Include a brief description of the nature of the problem.

Berry Electronics, Inc. products covered under terms of the above specified warranty will be repaired or replaced at Berry Electronics, Inc. expense. All other repairs will be at the customer's expense. Charges are based on a flat rate schedule.

D. Return Material

5.05 Whenever possible, Berry Electronics, Inc. products being returned for repair should be shipped in the original shipping carton. All instruments must be shipped to the following address:

BERRY ELECTRONICS, INC.

719 Swift Street, B-12

Santa Cruz, CA 95060

Attn: Repairs

CABEL SPINNING EQUIPMENT

Repair Center

100 West Central

New London, MN 56273

5.06 Equipment (in or out of warranty) when shipped by air freight will be repaired within 24 hours and reshipped air freight. Equipment received by surface freight will be repaired within 10 working days.

SECTION 100-314-A00

C. Preventive Maintenance

5.09 The 314A is designed and built to operate under normal central office conditions. Care should be taken to keep the test set free from excessively dusty or wet environments. Debris should be kept away from the control panel, especially the jacks. A soft cloth may be used to wipe the control panel free of dust.

5.10 If the batteries become discharged, they should not be left in the Test Set because of the possibility of electrolyte leaking causing corrosion. Either remove the old batteries and replace

with fresh batteries, or remove and discard the discharged cells (assuming the test set is to be operated on central office -48 V DC only).

5.11 To replace the batteries, turn off the 314A (including removing any external connection to -48V). Remove the four screws holding the battery plate at the bottom of the case. Replace the batteries with ten D-size Alkaline flashlight batteries, taking care to observe the polarity of the batteries inserted (the positive terminal is the round bottom end of each cell). Reattach the battery plate to the bottom of the case using the four screws that had been removed.

